Evaluation of New Insecticides for True Bug Control

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Abstract: True bugs were not considered to be major pear pests in the past. However, recent changes in the codling moth (CM) management have resulted in increased damage by true bugs. True bugs are often controlled indirectly by organophosphate (OP) insecticides that are applied for CM control. The pheromone mating disruption programs for CM has successfully suppressed CM, consequently, OP use was reduced by about 75%. Unfortunately, the reduced usage of OP insecticides resulted in a substantial increase in true bug. If outbreaks of true bugs occur in mating disrupted orchards and require OP or carbamate insecticide applications for their control, then the value of the IPM program that reduces OP insecticides use will be threatened. New true bug insecticides, which are effective, environmentally benign, biologically selective and exhibit low mammalian toxicity must be found and registered in order to reap the ecological benefits of the pheromone based CM management strategy.

From the 1999 studies, a number of insecticides were evaluated both in the laboratory and field for true bug control. The pyrethroid insecticides (Asana, Danitol) provided control over an extended period of time when the true bugs were caged for 12 hours on treated foliage. However, their use would be very disruptive to the pear ecosystem. The most promising new insecticide for true bug control is Provado. Provado is a nicotinoid insecticide and is registered for use on pears. It was found that to evaluate the nicotinoid insecticides the true bugs needed to be caged on treated foliage for greater than 12 hours. It was also found that the plastic zip-lock bag method of bioassay greatly underestimates the mortality of the pyrethroid and nicotinoid insecticides. Other methods of bioassay must be found for laboratory comparisons.

From the 2000 studies, a number of insecticides were evaluated both in the laboratory and field for Lygus bug (LB) control. The pyrethroid insecticides (Asana, Danitol, Baythroid, Brigade and Decis) provided exceptional control over an extended period of time when the true bugs were caged for 24 hours on treated foliage. Again, the use of pyrethroid insecticides would be very disruptive to the pear ecosystem. Field evaluations of the nicotinoid insecticides (Assail, Actara, Provado, Calypso, V-10066) provided very promising results. Provado and Actara were as efficacious as Dimethoate or Carzol and V-10066 was nearly as efficacious as the pyrethroid insecticides. It was found that foliage laboratory bioassay method provides the potential to better mimic the field efficacy of pyrethroid and nicotinoid insecticides.

Introduction: True bugs [*Lygus hesperus* Knight (western tarnished plant bug), *L. elisus* Van Duzee (pale legume plant bug), *Euschistus conspersus* (consperse stink bug), *Thyanta custator* McAtee (redshouldered stink bug), *Acrosternum hilare* Say (green stink bug), *Boisea trivittata* Say (boxelder bug) and others] have not historically been considered as major pests in pears. However, recent changes in the CM management strategy have resulted in increased damage by true bugs. True bugs do not develop in pears and nymphs are seldom found on pear trees. However, adults migrate from neighboring areas and orchard weeds to feed on developing fruit.

Adult feeding can cause lesions or dimples on the fruit. This feeding makes the pears unmarketable for either fresh market or cannery sale. True bugs had been controlled indirectly by organophosphate (OP) insecticides that are applied for codling moth (CM) control. The pheromone mating disruption programs for CM have significantly reduced the use of OP insecticides. Unfortunately, the reduced use of OP insecticides has resulted in a substantial increase in true bug damage. In some orchards using pheromone control for CM, damage was greater from the true bugs than from CM. If outbreaks of true bugs occur in mating disrupted orchards and require OP insecticides for their control, then the value reduce OP use will be lost. In addition, the implementation of the Food Quality Protection Act of 1996 may result in greatly extended pre-harvest intervals or terminate of registrations of many OP insecticides.

New true bug insecticides that are effective, environmentally benign, biologically selective, and exhibit low mammalian toxicity must be found and registered in the near future in order to reap the ecological benefits of the pheromone based CM management strategy. Reported here are the results of our laboratory and field insecticide evaluations on true bugs for both 1999 and 2000. The 1999 data is included here because it was inadvertently not included in the 1999 report.

Field Evaluations of Insecticides for True Bug Control in Pears - 1999

Methods and Materials: Two trials were conducted on mature 'Bartlett' pear trees in a commercial orchard near Hood, CA. Trial A consisted of five treatments and trial B consisted of eight treatments. Each treatment was replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction from the treated tree. Treatments were applied between 6:00 a.m. to 9:00 a.m. on 7 June for trial A and 12 July for trial B with a hand-held orchard sprayer operating at 200 psi and delivering 400 gal/acre of finished spray (1.33 gal/tree). Control in trial A was evaluated by caging 20 adult lygus bugs (LB) on the foliage for 12 hours (6:00 p.m. to 6:00 a.m.) at 0, 3, 7 and 14 days after treatment (DAT). Control in trial B was evaluated by caging 20 adult LB and 20 adult green stink bugs (GSB) in separate cages for each treatment on the foliage for 12 hours (6:00 p.m. to 6:00 a.m.) at 0, 3, 7 and 14 DAT.

Results and Discussion: All insecticide treatments in both trials resulted in significant true bug mortality compared to the untreated control at 0 DAT (Table 1). In trial A, Asana and Provado and in trial B, Danitol, both rates of Asana, and the two high rates of Provado provided excellent LB control while only Danitol and Asana provided excellent GSB control. At 3 DAT in trial A, all insecticide treatments provided significantly greater LB mortality as compared to the untreated control. In trial B, Danitol, both rates of Asana and the high rate of Provado provided significantly greater LB mortality compared to the untreated control with only the high rate of Asana providing excellent LB control. Danitol and Asana provided significant control of GSB but neither provided excellent control. Similar results were observed at 7 DAT, however, no treatment resulted in excellent control. At 14 DAT in trial B, mortality was greatly increased as compared to 7 DAT. Both rates of Asana for LB and Danitol for GSB provided greatly improved control. This increase in mortality was likely the result of higher temperatures over that period. The maximum air temperature at 7 DAT was 75˚F in trial B while the maximum air temperature

at 14 DAT was 85˚F. An increase in temperature appears to greatly increase the mortality of true bugs by both Asana and Danitol.

Table 1. Mean Percent Mortality of Caged Lygus and Green Stink Bugs at Hood, CA - 1999

		Mean[a] Percent Mortality DAT							
	Rate	0		3		7		14	
Treatment	lb. (AI)/ac	LB	GSB	LB	GSB	LB	GSB	LB	GSB
		Trial A							
1. Dimethoate E267	2.000	59 c	----	50 b	----	19 b	----	16 a	----
2. Asana XL	0.072	80 d	----	89 c	----	45 c	----	76 b	----
3. Provado 1.6F	0.250	74 d	----	54 b	----	40 c	----	23 a	----
4. Actara 25 WG	0.063	50 b	----	46 b	----	23 bc	----	18 a	----
5. Untreated	----	17 a	----	17 a	----	5 a	----	15 a	----
		Trial B							
1. Alert 2SC	0.313	59 c	----	23ab	----	13 a	----	43 ab	----
2. Asana XL	0.041	97 e	----	35 bc	----	19 ab	----	87 cd	----
3. Asana XL	0.072	100 e	97 c	91 e	29 b	31 bc	39 bc	90 d	51 b
4. Danitol 2.4 EC	0.394	96 e	98 c	61 d	38 b	43 c	59 c	59 bc	83 b
5. Provado 1.6F	0.063	48 b	----	9 a	----	8 a	----	34 ab	----
6. Provado 1.6F	0.125	80 d	----	22 ab	----	17 ab	----	28 a	----
7. Provado 1.6F	0.250	81 d	52 b	45 cd	13 a	8 a	15 ab	36 ab	20 a
8. Untreated	——	17 a	6 a	9 a	5 a	7 a	4 a	16 a	1 a

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Conclusion: LB and GSB were confined on the foliage for only 12 hours overnight achieving a rigorous evaluation of the insecticide treatments. Confining LB for 24 hours, or more would likely increase the efficacy of the insecticides (see Evaluation of Lygus Control at Various Periods of Foliar Exposure). However, if temperatures exceeding 90˚F during the day, then the high temperatures during the middle of the day would cause high control mortality. All experimental treatments provided a significantly higher mortality than the untreated control on the day of treatment. However, Alert and the lower two rates of Provado 1.6F were not significantly different than the untreated control at 3, 7 and 14 DAT. Danitol and the high rate of Asana XL were the only treatments with significantly greater mortality compared to the untreated control at every evaluation period and their effectiveness appears to be temperature dependent. The most promising new chemistry for true bug control is Provado. Research next year will concentrate on Provado and other nicotinoid insecticides that are being developed by various agricultural chemical manufacturers.

Lygus Bug Control at Various Periods of Foliar Exposure – 1999

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard near Fairfield, CA. Three treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree. Treatments were applied on 8 August between 6:00 a.m. to 9:00 a.m. with a hand-held orchard sprayer operating at 250 psi and delivering 200 gal/acre of finished spray (2.87 gal/tree). Control was evaluated by caging 20 adult LB on the foliage for 12, 24, and 48 hours starting at 6:00 p.m. on the day of treatment.

Results and Discussion: When LB were confined on the foliage for 12 hours, control was poor with either Dimethoate or Provado (Table 2). When LB were confined on the foliage for 24 hours, mortality of both Dimethoate and Provado increased without corresponding increase in the mortality in the untreated control. When the LB were confined on the foliage for 48 hours, control increased to an acceptable level with either Dimethoate or Provado. However, the mortality in the untreated control was approaching 25%, which is unacceptable. When corrected for untreated control mortality, the Dimethoate mortality increased substantially from 12 to 24 hours of confinement and then remained about the same for 48 hours of confinement while Provado mortality increased with length of time of LB confinement. Unfortunately, this study was conducted with moderate maximum air temperatures and control mortality could not be determined at high (90˚F) maximum air temperatures.

Table 2. Mean Percent Mortality of Caged Lygus Bugs for Various Period After Treatment at Fairfield, CA. - 1999

		Rate	Mean[a] Percent (Corrected) Mortality Hours after Treatment					
	Treatment	lb. (AI)/ac	12		24		48	
1)	Provado 1.6F	0.075	44 ab	(32)	61 b	(52)	88 b	(85)
2)	Dimethoate	1.340	53 b	(40)	79 b	(74)	81 b	(75)
3)	Untreated	——	17 a	----	19 a	----	23 a	----

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Conclusions: LB mortality increased with the time that the bugs were confined on foliage treated with either Dimethoate or Provado. The effect was more pronounced with Provado than Dimethoate. When moderate temperatures are predicted (max. air of about 75˚F), it appears that LB can be confined for 24 hours on foliage without unacceptable control mortality.

Evaluations of Pyrethroid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Fairfield, CA. Six treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction. Treatments were applied on 3 May with a hand-held orchard sprayer operating at 250 psi and delivering 250 gal/acre of finished spray volume (2.78 gal/tree). Control was evaluated by

caging 25 laboratory cultured, adult LB on the foliage for approximately 24 hours at 0, 7, 14, 21, 28, and 35 DAT.

Results and Discussion: LB were confined on the pear foliage for only 24 hours generating a rigorous evaluation of the insecticide treatments. Control of LB was excellent with all pyrethroid insecticides through 21 DAT (Table 3). LB mortality started to break down at 28 DAT for Brigade and at 35 DAT for Asana and Danitol. Control was excellent through the entire study for Decis and Baythroid. While high control mortality was observed in the untreated control, when maximum air temperatures exceeded 85˚F, the corrected mortality using Abbott's formula resulted in a similar mortality trend as the uncorrected mortality (Table 4).

Table 3. Mean Percent Mortality of Caged Lygus Bugs at Fairfield, CA – 2000

Treatment/	Rate	Percent Mortality DAT					
formulation	lb. (AI)/acre	0	7	14	21	28	35
Asana XL	0.072	100.0 b	93.9 b	82.5 b	93.1 bc	86.6 bc	76.7 bc
Baythroid 2EC	0.044	100.0 b	98.0 bc	100.0 c	100.0 c	92.0 bc	94.1 c
Brigade 10WP	0.080	100.0 b	95.0 bc	88.4 b	85.3 b	69.6 b	72.2 b
Decis 0.2EC	0.033	100.0 b	100.0 c	95.0 bc	93.3 bc	97.0 c	94.7 c
Danitol 2.4EC	0.394	100.0 b	91.0 b	95.0 bc	82.8 b	90.9 bc	73.1 bc
Untreated check	----	36.2 a	31.6 a	17.7 a	29.1 a	24.4 a	20.3 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Table 4. Mean Percent Corrected Mortality of Caged Lygus Bugs at Fairfield, CA - 2000

Treatment/	Rate	% Corrected Mortality DAT					
formulation	lb. (AI)/acre	0	7	14	21	28	35
Asana XL	0.072	100.0	91.1	78.7	90.3	82.3	69.2
Baythroid 2EC	0.044	100.0	97.1	100.0	100.0	89.4	92.2
Brigade 10WP	0.080	100.0	92.7	85.9	79.3	59.8	63.2
Decis 0.2EC	0.033	100.0	100.0	93.9	90.6	96.0	93.0
Danitol 2.4EC	0.394	100.0	86.8	93.9	75.7	88.0	64.4

Conclusions: All pyrethroid insecticides tested provided excellent LB control. Decis and Baythroid provided excellent control with over 90% control through 35 DAT.

Evaluation of Nicotinoid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Fairfield, CA. Eight treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction. The insecticides were applied on 12 June with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 250 gal/acre (2.78 gal/tree). Control was evaluated by caging 25

laboratory cultured, adult LB on the foliage for approximately 24 hours at 0, 3, 7, 14, 21, and 28 DAT.

Results and Discussion: Due to high maximum temperatures, control mortality was very high particularly at 0 DAT (Table 5). In an effort to reduce control mortality, all cages were covered with aluminum heat shields at 3 DAT. The heat shields helped reduce the control mortality. To correct for the control mortality, Abbott's formula was applied to the data. The Actara and Provado insecticide treatments provided significantly greater LB mortality compared to the untreated control at each evaluation period. The Actara and Provado treatments were especially efficacious and they are promising insecticides for true bug control. Calypso provided significantly greater LB mortality compared to the untreated control at each evaluation period after the 0 DAT evaluation. Assail was less efficacious than Calypso but showed some LB activity. Calypso and Assail were applied at 0.15 lb (AI)/ac in this trial. If Calypso and Assail were applied at 0.25 lb (AI)/ac, control might have been similar to that of Provado and Actara. Although Dimethoate provided 100% mortality at 0 DAT, control rapidly diminished and was not significantly different from the untreated control by 7 DAT. Carzol showed only fair mortality at 0 DAT and was not significantly different from the untreated control by 14 DAT. Avaunt does not appear to be a promising true bug insecticide

Table 5. Mean Percent Mortality of Caged Lygus Bugs at Fairfield, CA – 2000

Treatment/	Rate	Percent Mortality DAT					
formulation	lb. (AI)/acre	0	3	7	14	21	28
Calypso 4SC	0.150	59.5 b	50.9 c	53.0 bc	49.2 c	27.2 c	38.4 bc
Assail 70WP	0.150	35.8 a	48.6 bc	37.3 ab	44.6 bc	30.6 c	30.4 abc
Actara 25WG	0.250	96.0 cd	76.1 d	87.9 e	92.0 d	67.1 d	41.2 cd
Provado 1.6F	0.250	93.8 cd	74.1 d	81.3 de	81.0 d	64.5 d	60.0 d
Dimethoate E267	2.000	100.0 d	45.7 bc	29.1 a	20.6 a	22.1 bc	23.6 a
Carzol SP	0.920	85.4 c	54.7 c	63.8 cd	30.0 ab	13.9 ab	26.1 ab
Avaunt 30WG	0.110	64.4 b	35.5 ab	42.0 ab	29.2 ab	14.8 ab	18.4 a
Untreated check	----	51.1 ab	23.3 a	25.1 a	23.0 a	6.6 a	20.9 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Conclusion: Actara and Provado are promising new insecticides for true bug control with an extended period of activity. They provided as high or higher mortality than grower standards of Dimethoate or Carzol. Calypso and Assail should not be discounted as potential true bug materials but should be reevaluated at higher rates of application.

Rate Evaluations of Nicotinoid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Fairfield, CA. Nine treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction.

The insecticides were applied on 14 August with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 250 gal/acre (3.57 gal/tree). Control was evaluated by caging 25 laboratory cultured, adult LB on the foliage for approximately 24 hours at 0, 3, 7, 14, 21, and 28 DAT. Heat shields were used over the caged LB to reduce control mortality.

Results and Discussion: All the treatments provided significantly higher mortality compared to the untreated control at 0, 3, and 7 DAT except Dimethoate (Table 6). Dimethoate was not significantly different from the untreated control at 7 DAT and evaluations of Dimethoate were terminated at 21 DAT. Both Actara and Provado showed a rate response with Actara slightly outperforming Provado. V-10066 is a very promising new nicotinoid insecticide that gave significantly higher mortality compared to the untreated control throughout the study.

Conclusion: All nicotinoid insecticides provided excellent LB control for an extended period of time. V-10066 and the higher rate of Actara and Provado were especially efficacious. V-10066 was effective through 28 DAT.

Table 6. Mean Percent Mortality of Caged Lygus Bugs at Fairfield, CA. - 2000

Treatment/	Rate	Percent Mortality DAT					
Formulation	lb. (AI)/acre	0	3	7	14	21	28
Provado 1.6F	0.063	96.0 cd	88.0 cd	52.7 b	17.7 a	16.3 a	19.6 a
Provado 1.6F	0.125	98.1 de	96.0 ef	67.6 b	27.5 ab	35.7 bcd	21.1 a
Provado 1.6F	0.250	100.0 e	94.1 def	92.9 c	30.7 ab	31.7 abc	22.7 a
Actara 25 WG	0.063	85.8 b	82.1 c	55.4 b	16.1 a	17.0 ab	21.4 a
Actara 25 WG	0.125	97.3 cde	88.5 de	94.0 c	37.6 b	21.2 ab	22.3 a
Actara 25 WG	0.250	98.0 de	91.4 def	90.7 c	79.4 c	43.0 cd	26.7 ab
V-10066 50WDG	0.250	99.0 de	98.0 f	93.2 c	88.7 c	55.1 d	39.0 b
Dimethoate E267	2.000	90.9 bc	56.6 b	26.4 a	15.9 a	----	----
Untreated control	----	21.2 a	38.6 a	24.2 a	17.4 a	21.4 abc	24.2 a

Evaluation of Systemic Nicotinic Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Ukiah, CA. Seven treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction. Admire 2F and Platinum 2SC were applied at the popcorn stage, fingerling stage, or both popcorn and fingerling stages. The insecticides were applied on 23 March for the popcorn stage and on 27 April for the fingerling stage. Treatments were applied within a soil trench dug around the base of each tree extending to the drip line. The experimental insecticides were diluted into 25 gal of water and the finished volume was applied to the trench around each tree. After the diluted treatments were absorbed in the ground, an additional 25 gal of clean water was applied around the base of each tree. Control was evaluated by caging 25 laboratory cultured, adult LB on the foliage for approximately 24 hours on 28 April, 31 May and 27 June.

Results and Discussion: The effectiveness of the treatments was evaluated one month after application on 28 April. Admire 0.5 lb. (AI)/ac gave significantly higher LB mortality compared to the untreated control (Table 7). Admire at 0.25 lb. (AI)/ac and Platinum at 0.263 lb. (AI)/ac had a higher percent mortality than the untreated control, but did not differ significantly. The one month delay in evaluation allowed time for the systemic treatments to translocate within the trees. The fingerling timing treatments were not included 28 April evaluation since there was not sufficient time for the materials to translocate up the trees. The corrected mortality (Abbott's formula) showed that Admire at 0.5 lb. (AI)/ac had six times the mortality as Admire at 0.25 lb. (AI)/ac. The second evaluation on 31 May resulted in significantly higher LB mortality in Admire at 0.5 lb. (AI)/ac applied at popcorn stage compared to Admire at 0.5 lb. (AI)/ac applied at fingerling stage. There was no significant difference between Admire at 0.25 lb. (AI)/ac applied at both popcorn and fingerling stages and Admire at 0.5 lb. (AI)/ac applied at either popcorn or fingerling stage. This would indicate that an early application of at least 0.5 lb. (AI)/ac of Admire is required for enough material to reach the foliage and cause significant LB mortality. However, there was no significant difference between any experimental treatment and the untreated control. High mortality was observed in the untreated control when maximum air temperatures exceeded 85˚F. Due to the high control morality on the third evaluation of 27 June, no meaningful comparison can be made.

Table 7. Mean Percent Mortality of Lygus Bugs Caged on Trees Treated with Systemic Neonicotinoid Insecticide at Ukiah, CA - 2000

			Mean[a] Percent Mortality					
	Rate		28-Apr		31-May		27-Jun	
Treatment	lb. (AI)/acre	Timing[b]	Actual	Corr.	Actual	Corr.	Actual	Corr.
Admire 2F	0.500	PC	42.1 b	31.7	47.3 b	24.8	19.9 a	0.0
Admire 2F	0.250	PC+F	20.1 ab	5.8	23.6 ab	0.0	25.9 ab	0.0
Admire 2F	0.500	F	----	----	21.8 a	0.0	39.0 b	0.0
Platinum 2SC	0.263	PC	30.3 ab	17.8	25.5 ab	0.0	24.5 ab	0.0
Platinum 2SC	0.263	PC+F	21.2 ab	7.1	32.3 ab	3.4	43.0 b	4.7
Platinum 2SC	0.263	F	----	----	34.8 ab	7.0	26.1 ab	0.0
Untreated	——	——	15.2 a		29.9 ab		40.2 b	

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.
[b]PC = Popcorn and F = Fingerling

Conclusion: Results suggest that there is systemic activity from both Admire and Platinum in pear trees. However, the amount of Admire or Platinum needed to produce significant LB mortality in large pear trees is excess of 0.5 lb. (AI)/ac and or the timing of application may play a significant role in the efficacy of Admire or Platinum. Early applications appear to provide greater efficacy than later applications. A great deal more research is needed in this area.

Evaluations of Speed Sprayer Applied Neonicotinoid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Ukiah, CA adjacent to the Russian River. Foliar sprays were applied on 15 July using a speed sprayer operating at about 1.75 mph with a finished spray volume of 200 gal/acre. Carzol SP and Provado 1.6F were applied to two, unreplicated 1.5 acre plots. Control was evaluated by separately caging 25 laboratory cultured, adult LB, 10 GSB, 25 field captured boxelder bug (BB) nymphs and 10 adult BB on the foliage for 24 hours at 0, 3 and 10 DAT. Four cages were placed in the center of each treatment for each bug species and for each evaluation. At 3 and 10 DAT, D-VAC suction samples were taken from four different sampling areas from each treatment. The four D-VAC sampling areas were: 1) outside the orchard about 10 meters proximate to the Russian River, 2) along the edge between 1 to 3 rows into the orchard, 3) in the middle of each plot and 4) immediately outside the treated plot approximately 5 meters further into the orchard.

Results and Discussion: Provado showed significantly higher LB mortality compared to Carzol and the untreated control at 0 DAT (Table 8). However, there was no significant difference in GSB mortality among the treatments at 0 DAT. Adult and nymph BB mortality was not evaluated at 0 DAT. Provado showed significantly higher LB and GSB mortality compared to

the untreated control at 3 DAT but there was no significant difference between Provado and Carzol. There was no significant difference in adult or nymph BB mortality across the treatments. Carzol provided higher mortality than Provado or the untreated control at 3 DAT. It is possible that BB adults and nymphs were not feeding to any great extent in pears and Carzol, which has more immediate contact active than Provado, caused the mortality through contact instead of injestion. At 10 DAT, there was no significant difference among the treatments in LB, GSB or BB mortality.

In the D-VAC suction samples, Provado appeared to provide some measure of control against both adult and nymph LB (Table 9). No LB adults or nymphs were observed in samples taken from within the Provado treated area while low numbers of LB adults and nymphs were observed from within the untreated control and Carzol treatments. Most BB adults and nymphs were found in samples outside of the treated area, adjacent to the river. No meaningful results can be drawn from this D-VAC work since there were often less true bugs found in the untreated control than in the insecticide treatments.

Table 8. Mean Percent Mortality of Adult and Nymph Lygus Bugs, Stink Bugs and Boxelder Bugs in Ukiah, CA - 2000

		Mean[a] Percent Mortality			
		0 DAT			
Treatment	Rate lb. (AI)/ac	LB	GSB	BB nymph	BB adult
Carzol SP	1.54	36.4 a	20.0 a	---	---
Provado 1.6F	0.25	79.9 b	30.0 a	---	---
Untreated	----	25.9 a	6.7 a	---	---
		3 DAT			
Carzol SP	1.54	28.4 ab	13.3 ab	21.3 a	45.6 a
Provado 1.6F	0.25	60.8 b	53.3 b	1.5 a	20.0 a
Untreated	----	9.2 a	0.0 a	1.7 a	26.7 a
		10 DAT			
Carzol SP	1.54	33.3 a	3.3 a	6.7 a	0.0
Provado 1.6F	0.25	30.8 a	0.0 a	0.0 a	0.1
Untreated	----	34.1 a	3.3 a	0.0 a	0.0

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation

Table 9. Number of Nymph and Adult Lygus and Boxelder Bugs captured in D-VAC suction samples at 3 DAT and 10 DAT at Ukiah, CA – 2000

	3 DAT

Treatment	Rate lb. (AI)/ac	Lygus Nymph I	II	III	IV	Lygus Adult I	II	III	IV
Carzol SP	1.54	1	0	12	22	1	0	0	7
Provado 1.6F	0.25	0	0	0	0	0	0	0	0
Untreated	----	0	1	1	3	0	0	2	1
		Boxelder Nymph				Boxelder Adult			
		I	II	III	IV	I	II	III	IV
Carzol SP	1.54	1	1	1	1	2	0	0	0
Provado 1.6F	0.25	14	0	2	0	0	0	0	0
Untreated	----	5	0	0	1	0	0	0	0

		10 DAT							
		Lygus Nymph				Lygus Adult			
		I	II	III	IV	I	II	III	IV
Carzol SP	1.54	0	0	2	0	0	0	2	0
Provado 1.6F	0.25	0	0	0	0	0	0	0	0
Untreated	----	0	0	0	0	1	0	0	0
		Boxelder Nymph				Boxelder Adult			
		I	II	III	IV	I	II	III	IV
Carzol SP	1.54	0	0	0	0	3	0	0	1
Provado 1.6F	0.25	14	0	2	0	0	0	0	0
Untreated	----	0	0	0	1	1	0	0	0

I- approximately 10 meters outside the orchard and adjacent the Russian River
II- along the edge of the treated plot
III- within each treated plot
IV- approximately 5 meters outside the treated plot, and further into the orchard

Conclusion: It appears that Provado was more effective in LB and GSB control than Carzol while there is some indication that Carzol may be more effective than Provado for BB control.

Laboratory-Plastic Bag Bioassays of New Insecticides for Lygus and Stink Bug Control - 1999

Methods and Materials: Plastic zip-lock bags (2 to 3 in.) were treated with 10 µl of pesticide diluted in acetone. The pesticide was allowed to dry. Fourteen adult female LB were placed in a plastic zip-lock bag with two small pinto beans. The pinto beans act as spacers. Two bags of each concentration were used for analysis. The bags were held at 73-77˚F and mortality was determined after 24 hours. Each potential true bug insecticide was first screened over a wide range on concentrations. The plastic bags were treated with a series of concentrations from 0.1 to 100 times the field rate. If the preliminary LD_{50} was greater than 50 times the field rate, then there were no further laboratory evaluations of the material. If a material showed some promise, then the plastic bags were treated with a series of five to six concentrations of the insecticide. The concentrations of the insecticide were within the expected LD_{10} to LD_{90} range.

Thirteen adult male GSB were placed with their dorsal side on a sticky surface. A dilution series of the potential insecticide was made in acetone. Each adult GSB was treated on the ventral surface of the abdomen with 3µl of pesticide solution using a micro-syringe. The GSB were held at 80˚F in a growth chamber and mortality was determined after 24 hours.

Results and Discussion: Eight insecticides were screened for LB LD_{50} values. Two insecticides, Alert SC (chlorfenapyr) and Success 2SC (spinosad), had LD_{50} values greater than 50 times the indicated field rate. Further laboratory evaluations of these two insecticides were suspended. Probit analysis of the dose mortality data from the remaining six insecticides indicated that Dimethoate achieved an acceptable level of control with a LD_{50} below the field rate (Table 10). However, the LD_{50} values of Brigade and Asana were not as encouraging at no less than 4.7 times the field rate. Only Provado had a LD_{50} value similar to Dimethoate. Given that Asana provided good control in our field trials (see Table 10), it appears that the bag bioassay method may not be an appropriate method of estimating field efficacy for LB control. Further research will be conducted to develop an appropriate insecticide screening bioassay method for LB control. These results may be explained based on the temperature in which the LB were held in the bioassays. Field trials indicated that Asana mortality was temperature dependent. The laboratory bioassays were conducted at 77˚F or less which might explain the lower than expected mortality. It is also possible that confining the LB in the plastic bag increased the fuming action of Dimethoate and improved its efficacy. The direct topical applications of Dimethoate and Asana on adult GSB produced a LD_{50} at 0.1 times the field rate for Dimethoate and a LD_{50} at 1 time the field rate for Asana (Table 11). Again these results are not what was expected based on field trials. Further research will be conducted next year to improve the bioassay.

Table 10. Laboratory Bioassays for Lygus Bug Control Using Potential Insecticides using 24 hour mortality.

	Rate	Field Rate	LC_{50} (95% CL)	
Trade Name	g (AI)/l	amount/100 gal.	g (AI)/l	n x field rate
Dimethoate E267	2.4	6.0 pt	1.7 (1.4-1.9)	0.7 (0.6-0.8)
Brigade 10 WP	0.12	1.0 lb.	0.9 (0.7-1.0)	7.1 (5.8-8.1)
Asana 0.66EC	0.09	14.5 oz	0.6 (0.5-0.8)	6.6 (5.3-8.6)
Asana 0.66EC	0.09	14.5 oz	0.4 (0.3-0.5)	4.7 (3.5-5.8)
Pounce 3.2 EC	0.48	16.0 oz	5.2 (3.6-12.8)	10.8 (7.4-26.6)
Pounce 3.2 EC	0.48	16.0 oz	3.3 (2.4-4.8)	7.0 (5.1-9.9)
Pounce 3.2 EC	0.48	16.0 oz	3.5 (1.7-4.6)	7.3 (3.5-9.6)
Provado 1.6F	0.3	20.0 oz	0.4 (0.2-0.5)	1.2 (0.7-1.7)
Actara 25WG	0.09	0.3 lb.	0.6 (0.4-0.8)	6.4 (4.3-8.5)

Table 11. Laboratory Bioassays for Green Stink Bug Control Using Potential Insecticides

	Rate	Field Rate	LD_{50} (95% CL)	
Trade Name	g (AI)/l	amount/100 gal.	g (AI)/l	n x field rate
Dimethoate E267	2.4	6.0 pt	1.0 (0.1-0.5)	0.1 (0.1-0.2)
Asana 0.66EC	0.09	14.5 oz	0.1 (0.1-0.2)	1.0 (0.7-1.6)

Laboratory - Foliar Bioassays of New Insecticides for Lygus Control - 2000

Methods and Materials: Untreated pear tree shoots were collected from a commercial pear orchard in Fairfield, CA. Limbs were washed with a mild soap solution, rinsed clean, dried and prepared immediately for bioassays, or stored for no more than five days at about 5°C for later use. Prepared shoots were pruned and trimmed to an approximate standard length of about 0.75 meter. Shoots were individually secured into 1000 ml flasks filled with water. Leaves were allowed to dry completely prior to application. Treatments were applied thoroughly over leaf surfaces just to the point of run off using a hand held, mist atomizer. Each insecticide trial was composed of five rates and an untreated control with four replicates per rate of application except the Actara 25WG study, which had three replicates per rate of application. Each replicate consisted of one treated limb caged with 25 mature LB of mixed population (except treatment Actara 25WG which was tested with an all male population) and placed in the greenhouse. Each replicate was monitored at 24 and 48 hours after treatment for LB mortality.

Results and Discussion: These studies were conducted to determine a more accurate method in estimating LB toxicity than the bag method used the previous year. Three insecticides were screened for LB mortality. The LD_{50} values were determined using treated foliage held in the greenhouse. Provado gave excellent LB control and had a LD_{50} value of 0.08 g (AI)/l with LD_{50} value of about 1/4 times the field rate of 20 oz/ac (Table 11). This result is more encouraging and better mimics the field mortality. Thus, the foliage method of determining the LD_{50} values

provides a more realistic mortality values as compared to the bag method of determining the LD_{50} values. However, Actara, had a LD_{50} value of 0.26 g (AI)/l with LD_{50} value about 3 times the field rate of 0.3 lb/ac. This result was discouraging since Actara and Provado had similar field efficacy (see Table 5). Since the sex of the LB tested were mixed and could change from trial to trial, another trial was conducted with Actara using only males. All male population of LB exhibited a relatively poor capacity to control LB with a LD_{50} achieved at nearly three to five times the field rate. Assail was the least effective pesticide tested with LD_{50} value about 9 times the field rate of 0.2 lb/ac. These trials will be repeated next year with only females. However, it appears that foliage bioassay method provides the potential to better mimic the field efficacy.

Table 11. Laboratory Bioassays for True Bug Control Using New Insecticides using 48 hour mortality

Treatment/	Rate	Field Rate	LD_{50} (95% CL)	
Trade Name	g (AI)/l	Amount/100 gal.	g (AI)/l	n x field rate
Provado 1.6F	0.3	20.0oz	0.08 (0.04-0.12)	0.26 (0.13-0.40)
Assail 70WP	0.07	0.2 lb.	0.65 (0.44-0.96)	9.3 (6.3-13.7)
Actara 25WG)	0.09	0.3 lb.	0.26 (0.04-0.5)	2.9 (0.44-5.6)
Actara 25WG[ab]	0.09	0.3 lb.	0.42 (0.17-0.72)	4.7 (1.9-8.0)

[a] CL at 90%
[b] Male Lygus bugs

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